

AMENDMENTS TO CLAIMS

Claim 1 (Cancelled).

Claim 2 (New): A method for drilling for petroleum, comprising the steps of

- (a) erecting a derrick assembly on the ground;
- (b) mounting a drill on said derrick assembly, said drill including a hollow drill pipe having an upper end and a lower end and a drill bit attached to the lower end;
- (c) mounting a rotary assembly at said derrick assembly to provide motive power to rotate said drill bit in the ground to produce drill bit cuttings;
- (d) mounting a drilling mud circulation system at said derrick assembly to direct primary drilling mud into said upper end of said drill pipe, down through said drill pipe, out the lower end of said drill pipe, and up through a hole in the ground to produce auxiliary drilling mud containing drill bit cuttings;
- (e) providing a source of primary drilling mud for said circulation system, said mud including water and clay and substantially free of drill bit cuttings;
- (f) providing a first particle separation apparatus including
 - (i) at least one stationary wall defining a stationary separation chamber,
 - (ii) a feed inlet orifice formed in said chamber,

- 1 (iii) at least one rotary distributor in said chamber including a rotating distribution
2 disk including an upper surface,
3 (iv) a drive system for rotatably driving said rotary distributor to rotate said disk
4 and said upper surface at a speed in the range of 500 RPM to 10,000 RPM,
5 (v) at least first and second outlets formed in said wall,
6 (vi) an open particle circulation space intermediate said disk system and said
7 outlet and circumscribed by a portion of said wall, said outlet opening into
8 said particle circulation space,
9 (vii) a charging system for charging auxiliary drilling mud containing drill bit
10 cuttings through said orifice into said separation chamber toward said rotary
11 distributor such that said auxiliary drilling mud, at least in part, impinges said
12 upper surface, said rotary distributor providing the motive power to move
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14 at least a portion of the auxiliary drilling mud outwardly over said
15 upper surface and into said chamber away from said rotary distributor,
16 a first portion of said auxiliary drilling mud over said upper surface
17 and into said chamber in a primary continuous helical path of travel
18 away from said rotary distributor and said orifice through said
19 circulation space toward and into said outlet,
20 a second portion of the auxiliary drilling mud in a secondary
21 recirculating helical path of travel away from said rotary distributor and
22 said orifice through said circulation space toward said outlet and away
23 from said outlet back toward said rotary distributor:
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25 (g) rotating said drill into the ground with said rotary assembly to form said hole in the
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- 1 ground and produce drill bit cuttings in said hole, said hole having a top and a side;
2 (h) circulating primary drilling mud with said mud circulation system along a path down
3 into said upper end of said drill pipe, through said drill pipe, out said lower end of
4 said drill pipe, up through said hole intermediate said drill pipe and said side of said
5 hole, and out through said top of said hole, to produce said auxiliary drilling mud
6 containing drill bit cuttings;
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8 (i) operating said a drive system to rotate said upper surface at a speed in the range
9 of 500 RPM to 10,000 RPM;
10 (j) transporting to said charging system said auxiliary drilling mud, said charging
11 system directing said auxiliary drilling mud through said inlet orifice into said
12 stationary separation chamber toward said rotary distributor such that the material
13 directed through said inlet orifice is at least fifty percent by weight liquid and such
14 that said auxiliary drilling mud, at least in part, impinges said rotating upper surface
15 such that
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17 (i) first dry material including clay passes outwardly from within said stationary
18 wall through said first outlet, and
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20 (ii) second dry material passes outwardly from within said stationary wall
21 through said second outlet;
22 (k) transporting at least said first dry material to a landfill; and,
23 (l) depositing said first dry material in the landfill.

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25 Claim 3 (New): A method for drilling for petroleum, comprising the steps of

- 26 (a) erecting a derrick assembly on the ground;
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28 (b) mounting a drill on said derrick assembly, said drill including a hollow drill pipe

- 1 having an upper end and a lower end and a drill bit attached to the lower end;
- 2 (c) mounting a rotary assembly at said derrick assembly to provide motive power to
- 3 rotate said drill bit in the ground to produce drill bit cuttings;
- 4 (d) mounting a drilling mud circulation system at said derrick assembly to direct primary
- 5 drilling mud into said upper end of said drill pipe, down through said drill pipe, out
- 6 the lower end of said drill pipe, and up through a hole in the ground to produce
- 7 auxiliary drilling mud containing drill bit cuttings;
- 8 (e) providing a source of said primary drilling mud for said circulation system, said mud
- 9 including water and clay and substantially free of drill bit cuttings;
- 10 (f) providing a particle separation apparatus including
- 11 (i) a first stationary wall defining a first stationary separation chamber,
- 12 (ii) a feed inlet orifice formed in said chamber,
- 13 (iii) at least one rotary distributor including
- 14 a first end of a hollow rotating shaft, said first end positioned in said
- 15 chamber, said rotating shaft also including a second end located
- 16 outside said chamber, and
- 17 a first distribution disk mounted on said first end to rotate in said
- 18 chamber simultaneously with said shaft and including an upper
- 19 surface,
- 20 (iv) at least a first outlet formed in said wall,
- 21 (vi) an open first particle circulation space intermediate said disk and said outlet
- 22 and circumscribed by a portion of said wall, said outlet opening into said
- 23 particle circulation space,
- 24 (vii) a charging system for charging auxiliary drilling mud through said orifice into
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1 said first separation chamber toward said disk such that said auxiliary drilling
2 mud, at least in part, impinges said upper surface, said rotating distribution
3 disk providing the motive power to move

4 at least a portion of said auxiliary drilling mud outwardly over said
5 upper surface and into said chamber away from said disc,

6 a first portion of the auxiliary drilling mud over said upper surface
7 and into said chamber in a primary continuous helical path of travel
8 away from said rotary disc and said orifice through said circulation
9 space toward and into and through said outlet as a dry fraction
10 including clay,

11 a second portion of the auxiliary drilling mud in a secondary
12 recirculating helical path of travel away from said rotary distributor and
13 said orifice through said circulation space toward said outlet and away
14 from said outlet back toward said rotary distributor and into said first
15 end of and rotatably through said hollow rotary shaft,

16 (viii) a second stationary wall defining a second stationary separation chamber,

17 (ix) at least a second rotary distributor including

18 said second end of said hollow rotating shaft positioned in said
19 second chamber, and

20 a second distribution disk mounted on said second end to rotate in
21 said second chamber simultaneously with said second end and
22 including an upper surface,

23 (x) at least a second outlet formed in said second wall,

24 (xi) an open second particle circulation space intermediate said second disk and
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1 said second outlet and circumscribed by a portion of said second wall, said
2 second end of said hollow rotary shaft opening into said second particle
3 circulation space such that said second portion of said auxiliary drilling mud
4 rotatably exits from said second end, travels toward said second disk such
5 that said second portion, at least in part, impinges said upper surface of said
6 second disk, said second rotating disk providing the motive power to move

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8 at least a portion of the auxiliary drilling mud outwardly over said
9 upper surface of said second disk and into said second chamber
10 away from said second disk,

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12 a primary portion of said second portion over said upper surface
13 of said second disk and into said second chamber in a primary
14 continuous helical path of travel away from said second disk away
15 from said second end through said second circulation space toward
16 and into and through said second outlet as a liquid portion including
17 water,

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19 a secondary portion of said second portion in a secondary
20 recirculating helical path of travel away from said second disk and
21 said second end through said second circulation space toward said
22 second outlet and then away from said second outlet back toward
23 said second end of said rotary shaft,

24 (xii) a drive system to rotatably turn said hollow rotary shaft at a speed in
25 the range of 500 RPM to 10,000 RPM, and

26 (xiii) a return system to direct said liquid portion into said source of said
27 primary drilling mud before said primary drilling mud is directed into
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1 said upper end of said drill pipe;

2 (h) rotating said drill into the ground with said rotary assembly to form said hole in the
3 ground and produce drill bit cuttings in said hole, said hole having a top and a side;

4 (i) operating said drilling mud circulation system and said return system to
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6 direct said liquid portion into said primary drill mud before said primary drilling
7 mud is directed into said upper end of said drill pipe, and

8 circulate drilling mud with said mud circulation system along a path down into
9 said upper end of said drill pipe, through said drill pipe, out said lower end of said
10 drill pipe, up through said hole intermediate said drill pipe and said side of said hole,
11 and out through said top of said hole, to produce said auxiliary drilling mud
12 containing drill bit cuttings;

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14 (j) operating said drive system to rotate said upper surface of said first distribution disk
15 and of said second distribution disk at a speed in the range of 500 RPM to 10,000
16 RPM;

17 (k) transporting to said charging system said auxiliary drilling mud, said charging
18 system directing said auxiliary drilling mud through said inlet orifice into said first
19 stationary separation chamber toward said first distribution disk such that the
20 material directed through said inlet orifice is at least fifty percent by weight liquid and
21 such that said auxiliary drilling mud, at least in part, impinges said rotating upper
22 surface of said first distribution disk such that

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24 (i) first dry material including clay passes outwardly from within said stationary
25 wall into and through said first outlet,

26 (ii) second dry material passes outwardly from within said stationary wall into
27 and through said second outlet,
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- 1 (iii) said second portion rotatably travels into said first end of said hollow rotary
2 shaft, through said hollow shaft, and out said second end of said hollow
3 rotary shaft into said second separation chamber, and
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5 (iv) said secondary portion of said second portion travels into and through said
6 second outlet as a liquid portion including water;
7 (l) operating said return system to direct said liquid portion to said source of said
8 primary drilling mud before said primary drilling mud is directed into said upper end
9 of said drill pipe;
10 (m) transporting at least said first dry material to a landfill; and,
11 (n) depositing said first dry material in the landfill.
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14 Claim 4 (New): The method of Claim 3 wherein said liquid portion is substantially all water.
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16 Claim 5 (New): The method of Claim 3 wherein said circulation spaces are toroidal-shaped.
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18 Claim 6 (New): The method of Claim 2 wherein said circulation space is toroidal-shaped.
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20 Claim 7 (New): The method of Claim 3 wherein said liquid portion is substantially all water.
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23 Claim 8 (New): A method for drilling for petroleum, comprising the steps of
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- 24 (a) erecting a derrick assembly on the ground;
25 (b) mounting a drill on said derrick assembly, said drill including a hollow drill pipe
26 having an upper end and a lower end and a drill bit attached to the lower end;
27 (c) mounting a rotary assembly at said derrick assembly to provide motive power to
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- 1 rotate said drill bit in the ground to produce drill bit cuttings;
- 2 (d) mounting a drilling mud circulation system at said derrick assembly to direct primary
3 drilling mud into said upper end of said drill pipe, down through said drill pipe, out
4 the lower end of said drill pipe, and up through a hole in the ground to produce
5 auxiliary drilling mud containing drill bit cuttings;
- 6 (e) providing a source of said primary drilling mud for said circulation system, said mud
7 substantially free of drill bit cuttings and including water, clay and at least one
8 petroleum hydrocarbon;
- 9 (f) providing a particle separation apparatus including
- 10 (i) a first stationary wall defining a first stationary separation chamber,
- 11 (ii) a feed inlet orifice formed in said chamber,
- 12 (iii) at least one rotary distributor including
- 13 a first end of a hollow rotating shaft, said first end positioned in said
- 14 chamber, said rotating shaft also including a second end located
- 15 outside said chamber, and
- 16 a first distribution disk mounted on said first end to rotate in said
- 17 chamber simultaneously with said shaft and including an upper
- 18 surface,
- 19 (iv) at least a first outlet formed in said wall,
- 20 (vi) an open first particle circulation space intermediate said disk and said outlet
- 21 and circumscribed by a portion of said wall, said outlet opening into said
- 22 particle circulation space,
- 23 (vii) a charging system for charging auxiliary drilling mud through said orifice into
- 24 said first separation chamber toward said disk such that said auxiliary drilling
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1 mud, at least in part, impinges said upper surface, said rotating distribution
2 disk providing the motive power to move

3 at least a portion of said auxiliary drilling mud outwardly over said
4 upper surface and into said chamber away from said disc,

5 a first portion of the auxiliary drilling mud over said upper surface
6 and into said chamber in a primary continuous helical path of travel
7 away from said rotary disc and said orifice through said circulation
8 space toward and into and through said outlet as a dry fraction
9 including clay,
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11 a second portion of the auxiliary drilling mud in a secondary
12 recirculating helical path of travel away from said rotary distributor and
13 said orifice through said circulation space toward said outlet and away
14 from said outlet back toward said rotary distributor and into said first
15 end of and rotatably through said hollow rotary shaft,
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17 (viii) a second stationary wall defining a second stationary separation chamber,
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19 (ix) at least a second rotary distributor including
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21 said second end of said hollow rotating shaft positioned in said
22 second chamber, and

23 a second distribution disk mounted on said second end to rotate in
24 said second chamber simultaneously with said second end and
25 including an upper surface,

26 (x) at least a second and third outlets formed in said second wall,

27 (xi) an open second particle circulation space intermediate said second disk and
28 said second outlet and circumscribed by a portion of said second wall, said

1 second end of said hollow rotary shaft opening into said second particle
2 circulation space such that said second portion of said auxiliary drilling mud
3 rotatably exits from said second end, travels toward said second disk such
4 that said second portion, at least in part, impinges said upper surface of said
5 second disk, said second rotating disk providing the motive power to move

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7 at least a portion of the auxiliary drilling mud outwardly over said
8 upper surface of said second disk and into said second chamber
9 away from said second disk,

10 a primary portion of said second portion into said second chamber
11 in a primary helical path of travel away from said second disk and
12 away from said second end through said second circulation space
13 toward and into and through said second outlet as a first liquid portion
14 including a portion of said water,

15 a secondary portion of said second portion in a secondary
16 recirculating helical path of travel away from said second disk and
17 said second end through said second circulation space toward said
18 second outlet and then away from said second outlet back toward
19 said second end of said rotary shaft,

20 a tertiary portion of said second portion into said second
21 chamber in a primary helical path of travel away from said second
22 disk and away from said second end through said second circulation
23 space toward and into and through said third outlet as a second liquid
24 portion including a portion of said petroleum hydrocarbon,

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27 (xii) a drive system to rotatably turn said hollow rotary shaft at a speed in
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the range of 500 RPM to 10,000 RPM, and

(xiii) a return system to direct said liquid portion into said source of said primary drilling mud before said primary drilling mud is directed into said upper end of said drill pipe;

(h) rotating said drill into the ground with said rotary assembly to form said hole in the ground and produce drill bit cuttings in said hole, said hole having a top and a side;

(i) operating said drilling mud circulation system and said return system to

direct said liquid portion into said primary drill mud before said primary drilling mud is directed into said upper end of said drill pipe, and

circulate drilling mud with said mud circulation system along a path down into said upper end of said drill pipe, through said drill pipe, out said lower end of said drill pipe, up through said hole intermediate said drill pipe and said side of said hole, and out through said top of said hole, to produce said auxiliary drilling mud containing drill bit cuttings;

(j) operating said drive system to rotate said upper surface of said first distribution disk and of said second distribution disk at a speed in the range of 500 RPM to 10,000 RPM;

(k) transporting to said charging system said auxiliary drilling mud, said charging system directing said auxiliary drilling mud through said inlet orifice into said first stationary separation chamber toward said first distribution disk such that the material directed through said inlet orifice is at least fifty percent by weight liquid and such that said auxiliary drilling mud, at least in part, impinges said rotating upper surface of said first distribution disk such that

(i) first dry material including clay passes outwardly from within said stationary

- 1 wall into and through said first outlet,
- 2 (ii) second dry material passes outwardly from within said stationary wall into
- 3 and through said second outlet,
- 4 (iii) said second portion rotatably travels into said first end of said hollow rotary
- 5 shaft, through said hollow shaft, and out said second end of said hollow
- 6 rotary shaft into said second separation chamber,
- 7 (iv) said secondary portion of said second portion travels into and through said
- 8 second outlet as a first liquid portion including water, and
- 9 (v) said tertiary portion of said second portion travels into and through said third
- 10 outlet as a second liquid portion including petroleum hydrocarbon;
- 11 (l) operating said return system to direct said first liquid portion to said source of said
- 12 primary drilling mud before said primary drilling mud is directed into said upper end
- 13 of said drill pipe;
- 14 (m) transporting at least said first dry material to a landfill; and,
- 15 (n) depositing said first dry material in the landfill.

19 Claim 9 (New): The method of Claim 8 wherein said first liquid portion is substantially all

20 water and said second liquid portion is substantially all petroleum hydrocarbon.

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20 23 Claim 10 (New): The method of Claim 5 wherein said circulation spaces each have a

24 conical base with a side at an angle (A) from the vertical and with a height (F) wherein the

25 ratio of said angle (A) to said height (F) is in the range of 2:1 to 12:1.

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28 Claim 11 (New): The method of Claim 6 wherein said circulation space has a conical base

1 with a side at an angle (A) from the vertical and with a height (F) wherein the ratio of said
2 angle (A) to said height (F) is in the range of 2:1 to 12:1.
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4 Claim 12 (New): The method of Claim 11 wherein said circulation space has a cylindrical
5 portion with a side having a height (B) that is less than about four times the diameter (C)
6 of said cylindrical portion.
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9 Claim 13 (New): The method of Claim 10 wherein said circulation spaces each have a
10 cylindrical portion with a side having a height (B) that is less than about four times the
11 diameter (C) of said cylindrical portion.
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14 Claim 14 (New): The method of claim 12 wherein said particle separation apparatus is
15 shaped and dimension to permit one hundred to two-hundred and fifty gallons per minute
16 of said auxiliary drilling mud to be processed by said particle separation apparatus.
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18 Claim 15 (New): The method of Claim 13 wherein said particle separation apparatus is
19 shaped and dimensioned to permit one hundred to two-hundred and fifty gallons per
20 minute of said auxiliary drilling mud to be processed by said particle separation apparatus.
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